

1 Claims

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3 1. An electrochemical sensor comprising:
4 an electrochemical cell having a sensor means;
5 fluid flow control means positioned so as to release a
6 fluid jet onto the sensor means, the fluid flow control
7 means having means for controlling the velocity of the
8 fluid jet, the fluid flow velocity being defined by the
9 Reynolds number of the fluid when the fluid is in the
10 fluid flow control means; and
11 wherein control of the Reynolds number and measurement of
12 the electrical output of the sensor provide a measure of
13 the build-up of scale on the working electrode.

14

15 2. An electrochemical sensor as claimed in claim 1
16 wherein, the measure of scale build up quantifies the
17 scale build up on the sensor surface in the
18 electrochemical cell.

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20 3. An electrochemical sensor as claimed in claim 1
21 wherein, the sensor detects scale build up to measure the
22 scaling tendency of the fluid.

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24 4. An electrochemical sensor as claimed in any
25 preceding claim wherein, the fluid control means is a
26 conduit provided with a control valve or pump.

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28 5. An electrochemical sensor as claimed in any
29 preceding claim wherein, the sensor measures the change
30 in electrical output as a function of Reynolds Number
31 during use of the fluid flow control means

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1 6. An electrochemical sensor as claimed in any
2 preceding claim wherein, the electrical output
3 measurement means measures the limiting current response
4 of the sensor as a function of Reynolds Number.

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6 7. An electrochemical sensor as claimed in any preceding
7 claim, wherein the fluid flow control means is a conduit
8 having a predefined diameter (d) and is positioned at a
9 height (H) above the sensor having a radius (r).

10

11 8. An electrochemical sensor as claimed in claim 7
12 wherein laminar flow of the fluid from the fluid control
13 means is provided by setting said diameter (d), height
14 (H) and radius (r).

15

16 9. An electrochemical sensor as claimed in claim 7
17 wherein $H/d = 1$; and $r/d < 0.5$.

18

19 10. An electrochemical sensor as claimed in any
20 preceding claim further comprising fluid sampling means
21 for obtaining a sample of a test fluid.

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23 11. An electrochemical sensor as claimed in any
24 preceding claim wherein, the fluid sampling means
25 contains fluid isolation means for isolating the test
26 fluid from a bulk fluid.

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28 12. An electrochemical sensor as claimed in claim 8
29 wherein , the fluid isolation means is provided by a
30 container having at least one sealable valve which, when
31 opened, allows the test fluid to enter the sampling
32 means.

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1 13. An electrochemical sensor as claimed in any
2 preceding claim wherein, the fluid flow control means
3 comprises a flow meter or flow sensor for measuring flow,
4 connected to a conduit from which said fluid jet is
5 expelled.

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7 14. An electrochemical sensor as claimed in any
8 preceding claim wherein, the sensor comprises a working
9 electrode, a counting electrode and a reference
10 electrode.

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12 15. An electrochemical sensor as claimed in any
13 preceding claim wherein, the electrochemical sensor
14 further comprises a reservoir for storing a second, pre-
15 prepared electrolyte, flow control means and one or more
16 conduits connected to the electrical cell such that the
17 pre-prepared electrolyte is used with the electrical cell
18 to measure the quantity of scale deposited by the test
19 fluid by measuring the electrical output of the cell as a
20 function of Reynolds number.

21
22 16. An electrochemical sensor as claimed in claim 15,
23 wherein the electrolyte is a solution.

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25 17. An electrochemical sensor as claimed in claim 15 or
26 claim 16 wherein, the electrolyte is a solution of brine
27 containing a suitable tracer.

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29 18. An electrochemical sensor as claimed in claim 17
30 wherein the tracer is ionic.

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32 19. An electrochemical sensor as claimed in claim 17
33 wherein the tracer is oxygen.

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2 20. An electrochemical sensor as claimed in claims 15 to
3 19 wherein, the pre-prepared solution has a saturation
4 ratio of less than 1.

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6 21. An electrochemical sensor as claimed in claims 15 to
7 20 wherein, the pre-prepared solution has a saturation
8 ratio of greater than 1.

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10 22. A method of measuring the scaling properties of a
11 test fluid, the method comprising the steps of:
12 controlling the velocity of a fluid jet as defined by the
13 Reynolds number of the fluid when the fluid is in a fluid
14 flow control means;
15 releasing the fluid jet from the fluid control means onto
16 a sensor of an electrochemical cell; and
17 measuring the electrical output from the sensor as a
18 function of the Reynolds number of the jet fluid, the
19 sensor being in contact with a sample of the test fluid.

20

21 23. The method of claim 20 wherein, the sensor gives a
22 measure of the change in electrical output as a function
23 of Reynolds number during use of the fluid flow control
24 means.

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26 24. The method of claim 22 or 23 wherein, the electrical
27 output provides a measure of the limiting current
28 response of the electrochemical cell as a function of
29 Reynolds Number.

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31 25. The method of claims 22 to 24, wherein the fluid flow
32 control means is a conduit having a predefined diameter

1 (d) and is positioned at a height (H) above the working
2 electrode or sensor having a radius (r).

3

4 26. The method of claim 25, wherein laminar flow of the
5 fluid from the fluid control means is provided by setting
6 said diameter (d), height (H) and radius (r).

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8 27. The method of claim 25 or claim 26 wherein $H/d = 1$;
9 and $r/d < 0.5$.

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11 28. A method as claimed in claims 22 to 27 comprising
12 the further step of isolating the test fluid from a
13 flowing fluid prior to measuring the electrical output
14 from the electrical cell as a function of the Reynolds
15 number of the fluid.

16

17 29. A method as claimed in claim 28 wherein, the test
18 fluid is isolated by closing valves arranged upstream and
19 downstream of a predetermined measuring location in a
20 sample measuring means.

21

22 30. A method as claimed in claims 22 to 29 wherein the
23 fluid is isolated by removably attaching a sampling
24 conduit to a first conduit in which the bulk of the fluid
25 is situated, and by providing valves to isolate the
26 sampling conduit from the first conduit.

27

28 31. A method of measuring the scaling properties of a
29 test fluid, the method comprising the steps of:
30 introducing a jet of test fluid into an electrochemical
31 cell so as to allow scale to build up on one or more
32 surfaces in the cell;
33 removing the test fluid from the electrochemical cell;

1 introducing a pre-prepared solution into the cell; and
2 measuring the electrical output from the electrochemical
3 cell.

4

5 32. A method as claimed in claim 31 wherein, the test
6 fluid is introduced into the electrochemical cell at a
7 rate defined by the Reynolds Number of the fluid when
8 contained in a first fluid control means.

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10 33. A method as claimed in claim 31 or claim 32 wherein,
11 the pre-prepared solution is introduced into the
12 electrochemical cell at a rate defined by the Reynolds
13 number of the fluid when contained in a second fluid
14 control means.

15

16 34. The method of claims 31 to 33 wherein, the
17 electrical output measures the change in electrical
18 output as a function of Reynolds Number during use of the
19 fluid flow control means.

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21 35. The method of claims 31 to 34 wherein, the
22 electrical output provides a measure of the limiting
23 current response of the electrochemical cell as a
24 function of Reynolds Number.

25

26 36. The method of claims 31 to 35, wherein the fluid flow
27 control means is a conduit having a predefined diameter
28 (d) and is positioned at a height (H) above the working
29 electrode or sensor having a radius (r).

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31 37. The method of claim 36, wherein laminar flow of the
32 fluid from the fluid control means is provided by setting
33 said diameter (d), height (H) and radius (r).

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2 38. The method of claim 36 or claim 37 wherein $H/d = 1$;
3 and $r/d < 0.5$.

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5 39. A method as claimed in any of claims 36 to claim 38
6 wherein, the pre-prepared solution has a saturation ratio
7 of less than 1.

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9 40. A method as claimed in any of claims 36 to claim 39
10 wherein, the pre-prepared solution has a saturation ratio
11 of greater than 1.

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